

Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-05	Revision 1
Title: FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers		Effective Date: December 20, 2011	Page 1 of 16

FSTD Guidance Bulletin 11-05

FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers

Purpose:

This Guidance Bulletin describes certain recommendations that are currently under FAA review with regard to Upset Recovery Training maneuvers. FSTD sponsors are provided these recommendations and the suggested criteria for evaluating an FSTD for Upset Recovery Training (URT) maneuvers. FSTDs currently qualified for Unusual Attitude maneuvers are also addressed.

Scope:

This Guidance Bulletin describes certain methods and procedures not currently required by the Code of Federal Regulations. Rulemaking processes in support of recent legislation are, however, under consideration to codify improved FSTD evaluation standards into regulation (14 CFR Part 60). The proposals described herein are provided as voluntary guidance and may or may not be included in any potential rule change. If an applicant chooses to utilize the approach described within this Guidance Bulletin, that applicant must adhere to all methods, procedures, and standards herein. Should an applicant desire to use another means to modify a qualified FSTD, a proposal must be submitted to the National Simulator Program Manager (NSPM) for review and approval prior to implementation as described in § 60.23.

Approval: Harlan G. Sparrow III
National Simulator Program Manager

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Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-05	Revision 1
Title: FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers		Effective Date: December 20, 2011	Page 2 of 16

REVISION HISTORY		
Rev	Description of Change	Effective Date
0	Original Draft.	12/19/2011
1	Enhance for clarity.	12/20/2011

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Title: FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers		Effective Date: December 20, 2011	Page 3 of 16

1. Background Information

1.1. Standardization and Rulemaking Efforts

1.1.1. Pilot Training Requirements

To date, the FAA has addressed “Unusual Attitude Recovery Training” for pilots in the Code of Federal Regulations (CFR), Chapter 14, Part 61^{1 2} and in the Practical Test Standards for both Private Pilot³ and Airline Transport Pilot/Aircraft Type Ratings.⁴ These test standards encompass recognition and recovery, but do not clearly define an unusual attitude.

1.1.2. The Airplane Upset Recovery Training Aid

In 1998, both industry and Government representatives collaborated to develop the *Airplane Upset Recovery Training Aid* (AURTA) with the intent to, “...increase the pilot’s ability to recognize and avoid situations that can lead to airplane upsets and improve the pilot’s ability to recover control of an airplane that has exceeded the normal flight regime.”

Subsequent revisions were released in 2004 and 2008.

1.1.3. Flight Simulator Training Device (FSTD) Requirements

To the extent of FSTD evaluation and qualification, Part 60 makes reference to Unusual Attitude Recovery training within the QPS Table A1B (3.f.), Tasks vs. Simulator Level. This reference adheres strictly to “Recovery from Unusual Attitudes” within the normal flight envelope.

1.1.4. International Committee for Aviation Training in Extended Envelopes (ICATEE)

In June of 2009, the Flight Simulation Group (FSG) of the Royal Aeronautical Society (RAeS) established the ICATEE working group to identify, research, and suggest guidelines for potential improvements of flight simulation training in extended flight envelopes. The FAA-NSP has developed much of the information contained in this bulletin in parallel with ICATEE deliberations and

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Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-05	Revision 1
Title: FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers		Effective Date: December 20, 2011	Page 4 of 16

continues to work with ICATEE in further refining URT qualification requirements.

1.1.5. Information for Operators (InFO)

On July 7, 2010, the FAA issued an Information for Operators (InFO 10010⁵), “Enhanced Upset Recovery Training.” Citing Loss of Control (LOC) as the leading cause of fatal accidents, the document recommended incorporation of the Airplane Upset Recovery Training Aid into flight crew training programs.

1.1.6. Public Law 111-216 (House Resolution 5900)

On August 1, 2010, H.R. 5900 was passed into law becoming The Airline Safety and Federal Aviation Administration Extension Act of 2010, Public Law #111-216. Section 208(b.) of this act requires the FAA to initiate rulemaking to require Part 121 air carriers to provide flight crewmember training (which may include FSTD training) to:

- (a.) Recognize and avoid a stall of an aircraft or, if not avoided, to recover from the stall; and
- (b.) Recognize and avoid an upset of an aircraft or, if not avoided, to execute such techniques as available data indicate are appropriate to recover from the upset in a given make, model, and series of aircraft”.⁶

2. Considerations

2.1. Upset/Unusual Attitudes Defined

An aircraft upset can be thought of as unexpectedly finding oneself in an unusual attitude although the terms “Upset” and “Unusual Attitude” have been used synonymously. As noted, neither Part 60 nor Part 61 specifically defines an “unusual attitude.”⁷ This fact, coupled with a lack of a decisive standard, has left some uncertainty as to what exactly constitutes an unusual attitude, and to what extent within the flight envelope that FSTD fidelity can be predicted in the consideration of a positive training experience.

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Title: FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers		Effective Date: December 20, 2011	Page 5 of 16

The Airplane Upset Recovery Training Aid, rev 2⁸ defines an airplane upset as an airplane in flight unintentionally exceeding the parameters normally experienced in line operations or training. These are:

- Pitch attitude greater than 25 degrees, nose up;
- Pitch attitude greater than 10 degrees, nose down;
- Bank angle greater than 45 degrees; and/or
- Flight at an airspeed inappropriate for conditions.

In conducting “Upset Recovery Training” (URT) tasks, it is understood that at least one of the unintentional conditions above is exceeded in any one scenario. To date, FAA qualified FSTDs have received qualification for “(Basic) Unusual Attitude Recovery” tasks within the normal flight envelope. The National Simulator Program of the FAA interprets these maneuvers as unintentional events that do not exceed the AURTA parameters stated above.

2.2. Flight Envelope Considerations

For the purposes of this document, the term “flight envelope” refers to the entire domain in which the FSTD is capable of being flown. This envelope can be further divided into three regions⁸ :

- **Flight Test Validated.** This is the region of the flight envelope which has been validated with flight test data, typically by comparing the performance of the FSTD against the flight test data through tests incorporated in the QTG. Within this region, there is **high** confidence that the simulator response is representative of the aircraft. Note that this region is not strictly limited to what has been tested in the QTG; as long as the aerodynamic math model has been conformed to the flight test results, that portion of the math model can be considered to be within the Flight Test Validated region.
- **Wind Tunnel and/or Analytical.** This is the region of the flight envelope for which the FSTD has not been compared to flight test data, but for which there has been wind tunnel testing and/or

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Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-05	Revision 1
Title: FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers		Effective Date: December 20, 2011	Page 6 of 16

analysis carried out (typically by the aircraft manufacturer). Within this region, there is moderate confidence that the simulator's response is representative of the aircraft.

- **Extrapolated.** This is the region extrapolated beyond the flight test validated and wind tunnel/analytical regions. The extrapolation may be a linear extrapolation, a holding of the last value before the extrapolation began, or some other set of values. Whether this extrapolated data is provided by the aircraft or simulator manufacturer, it is a "best guess" only. Within this region, there is low confidence that the simulator's response will be representative of the aircraft.

These regions are generally determined by FSTD manufacturer and/or provider of the aerodynamic math model with direct knowledge of the validation data sources utilized in the development of the models.

2.3. Dynamic Stall/Stall Hysteresis Considerations

While not strictly within the realm of Upset Recovery Training, it is possible that the FSTD may inadvertently enter the stall region during training. Current requirements for FAA aircraft certification and FSTD qualification address stall maneuvers when conducted at a 1-g entry, 1 knot per second airspeed deceleration rate. 14 CFR Parts 23 and 25 aircraft certification tests, however, do also address banked entry at 30 degrees and 3-5 knot/sec decelerations (accelerated stalls). Because the stall and recovery characteristics of accelerated stalls may vary considerably from the 1-g entry stall, consideration should be given in developing training programs to ensure that any stall or approach to stall conditions encountered during training have been properly evaluated in accordance with the applicable simulator standards. See the NSP Guidance Bulletin "Proposed FSTD Requirements for Enhanced Stall Training Tasks."

2.4. Other Limitations

In addition to the aerodynamic flight limits for the flight envelope discussed in Section 1.3, there are also airframe limits (aero load limits, structural g-loads, etc), and physiological limits (calculated g-forces) felt by the pilot if the maneuver was being conducted in a real aircraft.

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Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-05	Revision 1
Title: FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers		Effective Date: December 20, 2011	Page 7 of 16

2.5. FSTD Fidelity

If some part of URT training is performed outside of the FSTD's flight test validated or analytical flight envelope as discussed in 2.2 or beyond those limitations in 2.4, there is an increased risk that the FSTD will not respond as the aircraft being simulated thus resulting in a potentially negative training experience. To this end, the working groups have concluded that instructors are not currently provided adequate feedback with regard to the flight envelope regions, aircraft operational limits and student control input during URT maneuvers. Industry feedback has further indicated that instructors need this feedback during the FSTD training session and post-session during debrief where time will allow more adequate discussion.

3. Proposed FSTD URT Evaluation and Qualification Criteria:

The ICATEE working group has made several recommendations to improve FSTD evaluation standards with regard to Upset Recovery Training (for maneuvers that exceed attitudes described in AURTA, rev 2). See Attachment A for a complete description of the proposed changes as recommended by the technical expert subcommittees. Attachment B contains the subcommittee's proposed amendments to the Part 60 Qualification Performance Standards (QPS) Tables.

Briefly Summarizing:

- 3.1 The flight envelope shall be divided into the three regions as defined in Section 2.2 above. This determination will typically be made by the FSTD manufacturer and/or provider of the aerodynamic math model with direct knowledge of the validation data sources utilized in the development of the models. The FSTD should also be able to track in real time which flight envelope region it is currently in, where it is in relation to the airframe limits described in Section 2.3 above, and
- 3.2 The FSTD must provide instructor feedback in a manner that will be evident when the FSTD is being operated outside of the defined flight envelope validation regions and/or when exceeding airframe limits. This

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Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-05	Revision 1
Title: FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers		Effective Date: December 20, 2011	Page 8 of 16

feedback may be in the form of an Alpha/Beta crossplot and a V-n plot. Additionally, a method for the instructor to evaluate the student control inputs must also be provided. The feedback must be available in the FSTD during the training session (real-time), and the ability to review these parameters following the simulator session is encouraged. An example Instructor Operating System (IOS) display containing relevant upset recovery training feedback information is depicted in Attachment C & D.

- 3.3 The FSTD must be evaluated for each specific URT maneuver to ensure that the combination of sideslip and angle of attack does not significantly exceed the range of validated or wind tunnel/analytically derived data. The following minimum set of maneuvers exceeding one or more of the AURTA parameters listed in 2.1 must be available to the instructor.

- 3.3.1. A nose-high, wings level aircraft upset
- 3.3.2. A nose-low, wings level aircraft upset
- 3.3.3. A high bank angle aircraft upset

Section 3 of the *Airplane Upset Recovery Training Aid* provides other recommended simulator training maneuvers which may be used within a sponsor's upset recovery training program.

- 3.4 Modifications to the FSTD flight model are not anticipated. A Statement of Compliance (SOC) is required that defines the source data used to construct the flight test and wind tunnel/analytical envelope. This SOC must verify that each upset recovery maneuver as defined on the FSTD's Statement of Qualification has been evaluated using the methods described in this section.

4. Summary and Interim Recommendations:

It is understood that operators may be conducting either Upset Recovery Training or (Basic) Unusual Attitude Recovery Training tasks within FAA approved training programs. These operators should be aware that rulemaking activities currently under consideration may include additional FSTD evaluation requirements for Upset Recovery Training tasks based upon the proposals presented within this bulletin. Until a final rule changing Part 60

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Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-05	Revision 1
Title: FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers		Effective Date: December 20, 2011	Page 9 of 16

is published, there are no additional FSTD requirements for sponsors conducting Basic Unusual Attitude Recovery or Upset Recovery Training tasks. In this interim period, however, all FSTD sponsors conducting such training are encouraged to assess their FSTDs and specific training maneuvers using the methods described in this bulletin and utilize their FSTDs accordingly. It is highly recommended that FSTD sponsors provide instructors with detailed guidance concerning specific FSTD limitations for use in an upset recovery training program.

Sponsors may, at their own discretion, voluntarily modify their FSTDs to accommodate Upset Recovery Training tasks (as proposed) ahead of any anticipated regulation. In doing so, sponsors must ensure that such modifications are reported to the NSPM in accordance with §60.23 at which time the NSPM may elect to conduct additional FSTD evaluations as determined necessary.

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Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-05	Revision 1
Title: FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers		Effective Date: December 20, 2011	Page 10 of 16

Attachment A:

Upset Recovery Maneuver Evaluation

1. **Basic Requirements:** The basic elements for the qualification of upset recovery training maneuvers are:
 - a. To verify that the FSTD can be expected to remain within its designed validation envelope during the execution of available upset recovery training tasks.
 - b. To provide the instructor/evaluator with a minimum set of feedback tools to properly evaluate the student's performance in accomplishing an upset recovery training task
2. **Flight Envelopes Defined**

For the purposes of this document, the term "flight envelope" refers to the entire domain in which the FSTD is capable of being flown. This envelope can be further divided into three subdivisions (e.g. see Appendix 3-D of the *Airplane Upset Recovery Training Aid*):

- **Flight Test Validated.** This is the region of the flight envelope which has been validated with flight test data, typically by comparing the performance of the FSTD against the flight test data through tests incorporated in the QTG and other flight test data utilized to further extend the model beyond the minimum requirements. Within this region, there is **high** confidence that the simulator responds similarly to the aircraft. Note that this region is not strictly limited to what has been tested in the QTG; as long as the aerodynamic math model has been conformed to the flight test results, that portion of the math model can be considered to be within the Flight Test Validated region.
- **Wind Tunnel and/or Analytical.** This is the region of the flight envelope for which the FSTD has not been compared to flight test data, but for which there has been wind tunnel testing and/or the use of other reliable predictive methods (typically by the aircraft manufacturer) to define the aerodynamic model. Within this region, there is **moderate** confidence that the simulator will respond similarly to the aircraft.
- **Extrapolated.** This is the region extrapolated beyond the flight test validated and wind tunnel/analytical regions. The extrapolation

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Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-05	Revision 1
Title: FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers		Effective Date: December 20, 2011	Page 11 of 16

may be a linear extrapolation, a holding of the last value before the extrapolation began, or some other set of values. Whether this extrapolated data is provided by the aircraft or simulator manufacturer, it is a “best guess” only. Within this region, there is **low** confidence that the simulator will respond similarly to the aircraft.

3. Instructor Feedback Mechanism: For the instructor/evaluator to provide feedback to the student during URT maneuver training, additional information must be accessible that indicates the relative fidelity of the simulation, magnitude of student control inputs, and aircraft operational limits that could potentially affect the successful completion of the maneuver(s). At a minimum, the following must be available to the instructor/evaluator:

- a. Simulator Validation Envelope:** The FSTD must employ a method to record the FSTD’s expected level of fidelity with respect to the designed validation envelope. This must be displayed as an “alpha/beta” crossplot on the Instructor Operating System (IOS) or other alternate method to clearly convey the simulator’s fidelity level utilized during the maneuver.
- b. Flight Control Inputs:** The FSTD must employ a method for the instructor/evaluator to assess the student’s flight control input used to execute the upset recovery maneuver. Parameters which may not be easily assessed visually from the instructor station, such as rudder pedal displacement and control forces, should be included in this feedback mechanism.
- c. Aircraft Operational Limits:** The FSTD must employ a method to provide the instructor/evaluator with information concerning the aircraft limitations (such as normal load factor and airspeed limits found on a V-n diagram) that may affect the successful completion of the maneuver.

The ability to record and playback the described parameters is encouraged. An example FSTD “alpha/beta” envelope plot and IOS feedback mechanism are shown below in Attachment C and D.

Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-05	Revision 1
Title: FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers		Effective Date: December 20, 2011	Page 12 of 16

Attachment B:

Minimum Simulator Requirements						
	<<< QPS Requirements >>>	Simulator Levels				< Information >
Number	General Simulator Requirements	A	B	C	D	Notes
2.m. (new)	<p>Upset Recognition and Recovery.</p> <p>Aerodynamics Evaluation: The simulator must be capable of performing upset recognition and recovery tasks as defined on the simulator's Statement of Qualification. The simulator must be evaluated for each specific upset recovery maneuver for the purpose of determining that the combination of angle of attack and sideslip does not exceed the range of validated data or wind tunnel/analytical data during a typical recovery maneuver as defined in the sponsor's training program. The following minimum set of upset recovery maneuvers must be available to the instructor/evaluator. Other upset recovery scenarios as developed by the FSTD sponsor must be evaluated in the same manner.</p> <ul style="list-style-type: none"> ▪ A nose-high, wings level aircraft upset. ▪ A nose-low, wings level aircraft upset. ▪ A high bank angle aircraft upset. <p>Instructor Operating System (IOS): Selectable airplane upsets must provide guidance to the instructor concerning the method utilized to drive the FSTD into an upset condition including any malfunction or degradation in the FSTD's functionality required to initiate the upset. The intentional degradation of simulator functionality to drive an airplane upset is generally not acceptable unless used purely as a tool for repositioning with the pilot out of the loop. The simulator must also have a feedback</p>	X	X	X	X	<p>This section applies to the qualification of airplane upset maneuvers that exceed one or more of the following conditions:</p> <ul style="list-style-type: none"> ▪ Pitch attitude greater than 25 degrees, nose up ▪ Pitch attitude greater than 10 degrees, nose down ▪ Bank angle greater than 45 degrees ▪ Flight at airspeeds inappropriate for conditions. <p>Instructor Operating System (IOS) display (or equivalent method of instructor feedback) should contain features which clearly indicate to the instructor/evaluator when the simulator has exceeded its flight</p>

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Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-05	Revision 1
Title: FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers		Effective Date: December 20, 2011	Page 13 of 16

<p>mechanism in place to notify the instructor/evaluator when the simulator's validated envelope and aircraft operational limits have been exceeded during an upset recovery training task. The FSTD must also employ a method for the instructor/evaluator to assess the student's flight control inputs used to execute the upset recovery maneuver. The FSTD feedback mechanism must also have the capability to capture and replay an upset recovery scenario to debrief the students at either on onboard of off-board debriefing station.</p> <p>Statement of Compliance (SOC) is required that defines the source data used to construct the flight test and wind tunnel/analytical envelope. This SOC must verify that each upset recovery maneuver as defined on the FSTD's Statement of Qualification has been evaluated using the methods described in this section.</p>					test validated and wind tunnel/analytical envelope (typically displayed as an alpha/beta cross-plot). Additional capabilities should include instructor/evaluator feedback on aircraft operational limitations (V-n diagram) and control displacements, control forces, etc.
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Functions And Subjective Tests							
<<< QPS Requirements >>>							
Item Number	Operations Tasks	Simulator Level					
		A	B	C	D		
	Maneuvers						
6.i. (new)	Upset recognition and recovery maneuvers within the FSTD's validated envelope as defined on the Statement of Qualification.	X	X	X	X		

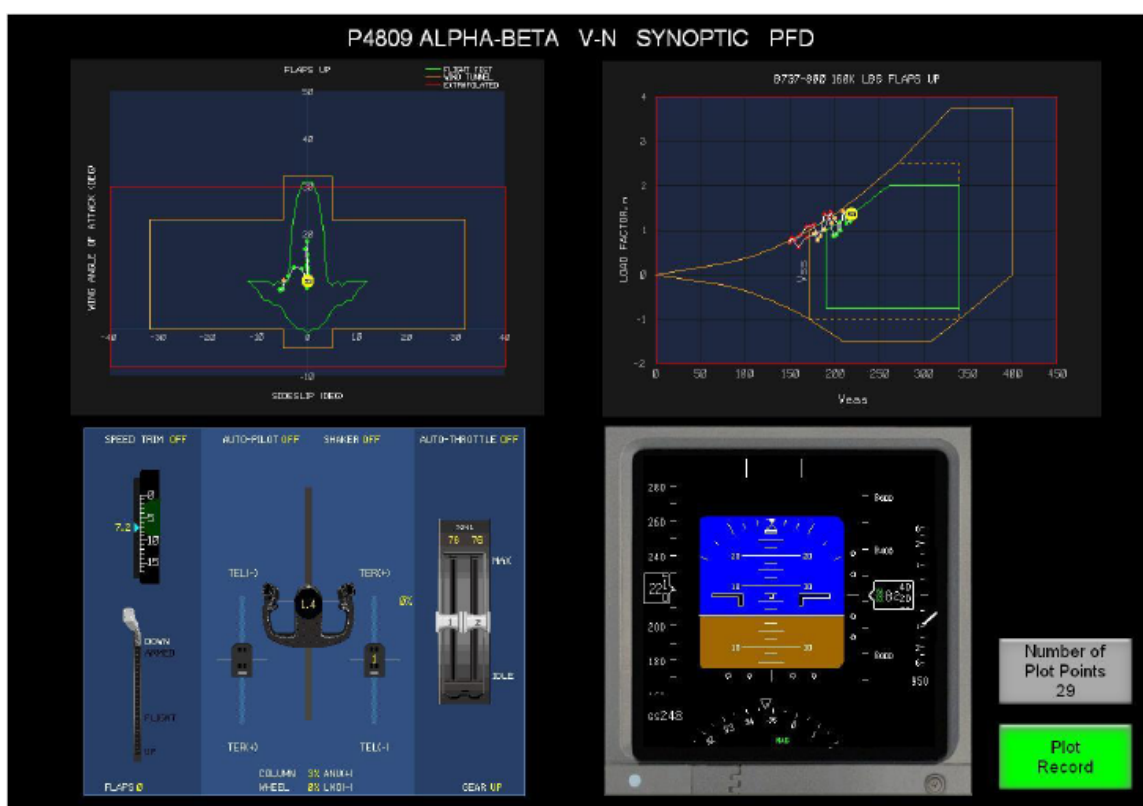
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Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-05	Revision 1
Title: FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers	Effective Date: December 20, 2011	Page 14 of 16	

Attachment C:

Example IOS Instructor URT Feedback Display



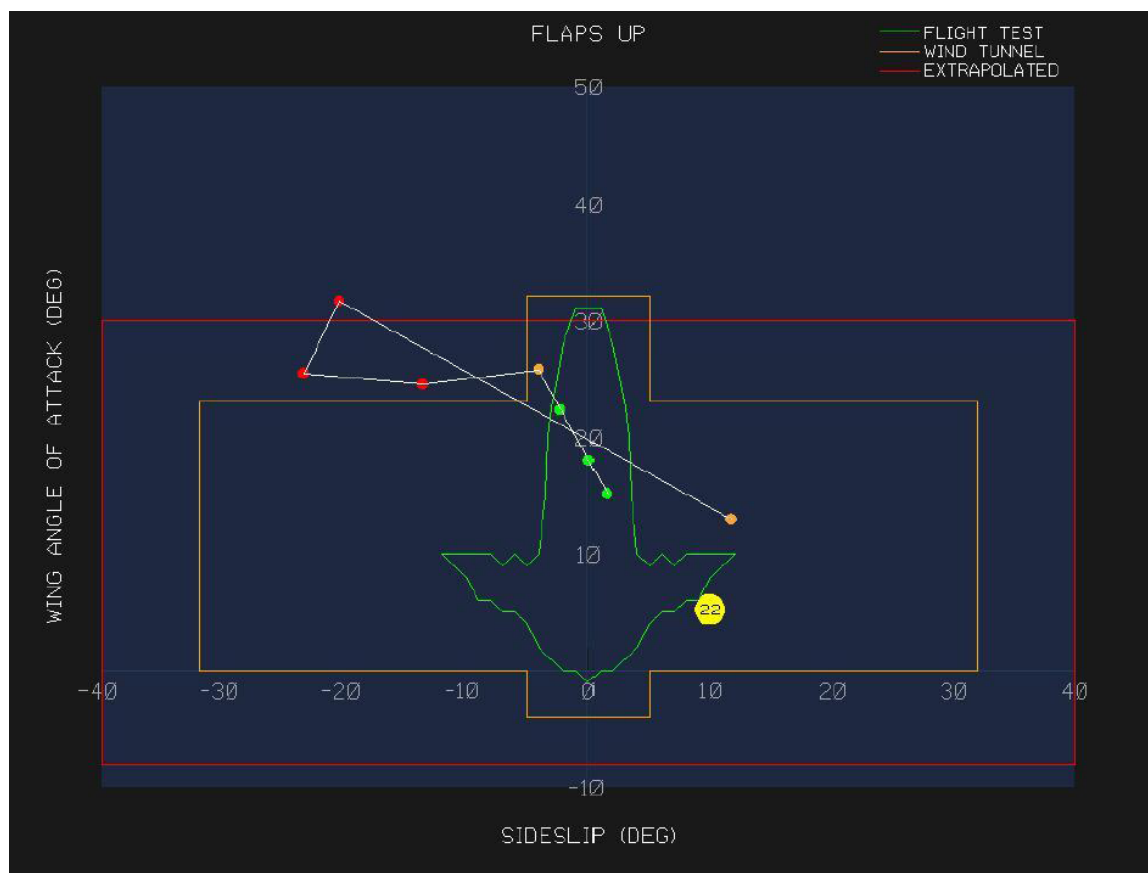
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Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-05	Revision 1
Title: FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers	Effective Date: December 20, 2011	Page 15 of 16	

Attachment D:

Example FSTD Alpha/Beta Envelope Plot showing feedback from a URT maneuver



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Federal Aviation Administration AFS-205 404.832.4700	National Simulator Program Flight Simulation Training Device Qualification Guidance	Guidance Bulletin Number: 11-05	Revision 1
Title: FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers		Effective Date: December 20, 2011	Page 16 of 16

Notes:

¹ CFR Chapter 14, Part 61, Certification: Pilots, Flight Instructors, and Ground Instructors. Subpart A: General, Section 57 Recent flight experience: Pilot in command; Subparagraph (c) Instrument experience (for IFR operations); also Subpart E: Private Pilots, Section 109 Aeronautical experience (for Private Pilots); also Subpart F: Commercial Pilots, Section 129 Aeronautical experience.

² CFR Chapter 14, Part 61, Certification: Pilots, Flight Instructors, and Ground Instructors. Subpart E: Private Pilots; Section 109 Aeronautical experience; Subparagraph (a)(3)

³ FAA-S-8081-14A with Change 1: PRIVATE PILOT – Practical Test Standards for Airplane, August 2002, Task E

⁴ FAA-S-8081-5F with Changes 1 & 2: AIRLINE TRANSPORT PILOT AND AIRCRAFT TYPE RATING – Practical Test Standards for Airplane, July 2008, Task F.

⁵ Information for Operators, InFO 10010 dated 7/6/2010. Web site:
http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/info/all_infos/media/2010/InFO10010.pdf

⁶ Training in adverse weather to include, microbursts, windshear, and icing conditions are also addressed: H.R. 5900 Airline Safety and Federal Aviation Administration Extension Act of 2010, TITLE II-AIRLINE SAFETY AND PILOT TRAINING IMPROVEMENT, Sec 208 Implementation of NTSB flight crewmember training recommendations. Also see NSP Guidance Bulletins for “FSTD Qualification for Enhanced Stall Training Tasks” and “FSTD Training in Icing Conditions ” at
http://www.faa.gov/about/initiatives/nsp/flight_training/bulletins/

⁷ Part 61, Subpart A, Section 57, Subpara (c) does specify airspeed conditions (V_{ne} and stall speed) to be met during these scenarios.

⁸ Airplane Upset Recovery Training Aid, Appendix 3-D

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